Question 1

1(c)(i)	gas syringe drawn / measuring cylinder (or burette) dipping into water drawn (1) apparatus closed, i.e. no air gaps (1)	**2**
1(c)(ii)	increases / goes faster	**1**
1(c)(iii)	increases / goes faster	**1**

Question 2

2(a)(i)	27 (cm^3)	**1**
2(a)(ii)	steeper initial gradient starting at 0-0 (1) line levels off at 44 cm^3 (1)	**2**
2(b)(i)	(rate) decreases / reaction slows down	**1**
2(b)(ii)	(rate) decreases / reaction slows down	**1**

Question 3

3(a)(i)	1.0 (mol / dm^3) 2.0 (mol / dm^3) 1.5 (mol / dm^3)	**1**
3(a)(ii)	takes longer time / time increases	**1**
3(a)(iii)	takes shorter time / time decreases	**1**

Question 4

4(a)(i)	29 cm^3	**1**
4(a)(ii)	steeper initial gradient starting at 0-0 (1) line levels off above 42 cm^3 (1)	**2**
4(b)(i)	rate faster / rate increases / reaction speeds up	**1**
4(b)(ii)	rate slower / rate decreases	**1**
4(c)	iron(II) chloride / iron chloride (1) hydrogen (1)	**2**
4(d)	substance that increases the rate of reaction (1) and is unchanged (at the end of the reaction) (1)	**2**

Question 5

5(a)(i)	reaction complete / reaction finished / no more sulfuric acid left	**1**
5(a)(ii)	3 min / 180 s (unit needed)	**1**
5(a)(iii)	line with steeper gradient and starting at (0,0)	**1**
	line ends at same volume and before the line already drawn	**1**
5(b)	faster reaction / rate increases / reaction speeds up	**1**
	(zinc) powder has a larger surface area **ORA**	**1**

Question 6

6(c)	large pieces: (rate) decreases / (reaction gets) slower (1) catalyst: (rate) increases / (reaction gets) faster (1) lower concentration: (rate) decreases / (reaction gets) slower (1)	**3**

Question 7

7(a)	180.42	**1**
7(b)	initial gradient steeper and line starts at 181.00 (1) line is curved and ends at same final volume (1)	**2**
7(c)	catalyst: rate increases / reaction faster / rate higher / reaction speeds up (1) concentration: rate decreases / reaction slower / rate lower / reaction slows down (1)	**2**
7(d)	95 (cm^3)	**1**

Question 8

8(b)(i)	1.0 2.0 0.5	**1**
8(b)(ii)	takes longer / time increases	**1**

Question 9

9(b)(v)	**M1** kinetic energy of particles increases (1) **M2** frequency of collisions between particles increases (1) **M3** higher percentage / proportion / fraction of collisions / particles have energy greater than / equal to activation energy (1) **or** more **of the** collisions / particles have energy greater than / equal to activation energy	**3**

Question 10

10(a)	**M1** increases the rate of reaction / speeds up a reaction(1) **M2** unchanged at the end of the reaction(1)	**2**
10(b)(i)	oxygen escapes from the flask or apparatus	**1**
10(b)(ii)	**concentration** of hydrogen peroxide is highest at the start / **particles** of hydrogen peroxide are closest together at the start **OR** **collision** frequency is highest at the start	**1**
10(b)(iii)	the **hydrogen peroxide** is used up / **ALL** the **hydrogen peroxide** has reacted or decomposed	**1**

10(c)	**M1** kinetic energy of particles increases(1) **M2** frequency of collisions between particles increases(1) **M3 more or** higher percentage **or** higher proportion **or** higher fraction of **particles** have energy greater than / equal to activation energy **OR** **more of the** collisions **or** higher percentage **or** higher fraction of **collisions** have energy greater than or equal to activation energy(1)	**3**
10(d)	**M1** (50.0 × 0.200 ÷ 1000 =) 0.01(1) **M2** 0.005(1) **M3** 0.16(0)(1)	**3**
10(e)	no effect	**1**

10(f)	$2HgO \rightarrow 2Hg + O_2$ **M1** all formulae correct(1) **M2** equation correct(1)	**2**

Question 11

11(a)	*test:* relights **AND** *observations:* a glowing splint	**1**
11(b)(i)	lower gradient (at t2)	**1**
11(b)(ii)	**M1** concentration (of H_2O_2 particles) decreases (1) **M2** frequency of collisions between particles decreases (1)	**2**

11(b)(iii)	**M1** steeper curve which does not cross original curve and levels off before the original curve (1) **M2** finishes at same volume (1)	**2**

Question 12

12(a)(i)	gradient decreases	**1**
12(a)(ii)	concentration of HC*l* is decreasing **OR** answers in terms of numbers of reactant molecules decreasing	**1**
12(a)(iii)	200 seconds	**1**
12(b)	new line steeper than printed line, starts at origin and levels before 200 seconds	**1**
	new line reaches same final volume as printed line	**1**
12(c)(i)	minimum energy that colliding particles	**1**
	must have to react	**1**

12(c)(ii)	(particles) have more energy and so move faster	**1**
	more frequent collisions between particles	**1**
	a greater percentage of collisions / particles have energy greater than the activation energy, E_a	**1**

Question 13

13(d)(i)	gradient (of line) decreases	**1**
13(d)(ii)	concentration of particles (of acid) decreases lower rate of collisions of particles	**2**

13(d)(iii)	a new line steeper than printed line and starts at origin and levels off earlier than printed line levels off at the same volume	**2**

Question 14

14(g)	**M1** rate decreases **and** particles have less energy (1) **M2** less collisions (between particles) occur per second / per unit time (1) **M3** less of the particles/collisions have energy equal to or above the activation energy (1) **or** less of the particles / collisions have sufficient energy to react **or** a lower percentage / proportion / fraction of collisions (of particles) • are successful or • have energy equal to or above activation energy	**3**